KOK-SAGHYZ RUBBER PRODUCTION PROGRAM.

C O N T E N T S

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Introduction

Kok-saghyz (coke-sahgeez) or Russian dandelion is a native of the mountains of Central Asia. The word "kok" means "root" and "saghyz" means "to chew," an indication that gum chewing is not unique with North Americans. Rubber is found in the roots of this plant, which the Russians have been growing for several years.

In the spring of 1942, several hundred pounds of kok-saghyz seed were flown to this country from Russia, so that tests could be made of the plant's adaptability to our soils, climatic conditions, etc. Later water shipments considerably increased the seed available for tests.

The write-up which follows is the work of a committee made up of representatives of several Department of Agriculture Bureaus; the Forest Service, the Bureau of Plant Industry, and the Bureau of Agricultural Chemistry and Engineering.

ACCOMPLISHMENTS DURING 1942

Where the Plant Grows Best

Since May, 1942, kok-saghyz or Russian dandelion, has been planted on some 175 acres at over 120 localities in forty-two states, Canada, and Alaska. The numerous small cooperative tests carried on by the Bureau of Plant Industry, and the additional larger sowings by the Forest Service, indicate that the plant can be successfully grown on soils rich in organic matter in the whole tier of northern states from Vermont to Oregon. The first year's growth of this plant in the United States does not indicate it to be as aggressive as our native dandelion, so it is not believed it is likely to become a pest on American farms. Fall plantings include many small cooperative tests and twenty-nine acres of more extensive sowings at four locations in the South to determine the root and seed production possibilities there.

(Over)

Seed Production and Collection

The plant seeds well in the North, and especially good seed production occurred in the Northwest. On the basis of seed collections this year, plus Russian experience, it seems safe to assume that 20 pounds of seed per acre will be produced the first growing season, and 50 pounds the spring of the second year, when the heaviest seed production can be expected. The plant is a perennial and holding over until the second year for seed production is good practice.

Because kok-saghyz seed is very small and light (1,000,000 per pound) seed collection when done by hand requires much labor. Accordingly, mechanical one and two-row seed pickers have been developed. A machine of Russian design has also been constructed and the best features of both the American and Russian machines are now being incorporated into a new four-row design.

Experiments in propagation of kok-saghyz by means of root cuttings have also been undertaken. Although the method would be costly, results to date are encouraging, so that propagation by this means could be used the first year as a supplement to sowing of seed in order to expand the acreage more rapidly.

Root Yields

Yields at the rate of 1,800 to 7,900 pounds of raw roots per acre were obtained in 1942 in the northern plantings, despite late sowing and a cold season. On this basis it seems probable that an average yield of 4,000 pounds of raw roots may be counted on at the end of the first growing season and perhaps somewhat more if only the very best soils are used and a normal or better growing season occurs.

Rubber Content and Calculation of Rubber Yield

Tests of sixteen lots of American-grown roots indicate an average rubber content of 4.5 per cent on a dry-weight basis. The roots tested were immature because of late sowing and in some cases plants of strains having low rubber content were no doubt included. Due to these facts, and because Russian averages are somewhat higher, it is believed that rubber content in the future will average 5 per cent. The Russian data from experimental plots (and probably from selected strains) show rubber contents up to 12 per cent, and even above. It is possible, therefore, that averages higher than 5 per cent rubber content might be obtained if all growing conditions were favorable and plantings were thoroughly rogued of types having low rubber content. The seed on hand, however, is very variable.

Assuming a yield of raw roots of 4,000 pounds per acre reducing to 840 pounds dry weight with a rubber content of 5 per cent, a yield of crude rubber of forty-two pounds per acre would be obtained. Allowing some loss because of spoilage of roots in storage (Russian literature indicates this to be a real factor unless especial care is exercised) a yield of 40 pounds per acre of crude rubber is thought to be a fair estimate of what may be expected.

Rubber Extraction

Some 18,000 pounds of roots dug the past fall from northern plantings in the Unites States are being run through extraction tests at the Department's Eastern Regional Research Laboratory in order to work out processing methods and to obtain sufficient rubber for suitable tests of its quality. On the basis of these preliminary investigations extraction appears to be relatively simple - simpler than the process used for guayule. The method proposed calls for recovery of fermentable carbohydrates from which alcohol can be made as a by-product. Assuming that the reducible sugars have a value equivalent to black-strap molasses, it is estimated that the by-products thus recovered will pay the entire cost of rubber extraction and return a profit which may be applied against other operations. Briefly, the process contemplated is about as follows:

After washing of roots, inulin, an easily fermented carbohydrate, is extracted from the whole roots by a counter-current hot water leach. The inulin is then hydrolyzed and fermented to alcohol. The material is then ready for rubber extraction. The whole roots are pebble milled a few minutes to break up the pulp and then passed over a vibrating screen to wash away soft plant material. The resulting tangled mass of rubber strings and pieces of root skins is pebble milled again to water log the skins. The rubber is then separated from the plant materials by flotation in which the rubber floats off and the detritus sinks.

Under this method the processing factories would operate on fresh roots from October to March, and on dry roots the other six months of the year. Suitable means of drying roots for spring and summer processing will have to be worked out.

Quality of Kok-saghyz Rubber

Although only preliminary data are now available from the tests being run in cooperation with the U. S. Rubber Company, it appears that the quality of rubber produced from kok-saghyz is high and that it could be used in the trade. It is superior to that from young guayule and more nearly resembles U. S. Rubber Company's "U. S. F. rubber." According to the Russian data, it has a slightly lower tensile strength than smoked sheet and pale crepe. But kok-saghyz rubber excels in rapidity of vulcanization. In combination with synthetics (1:1) kok-saghyz rubber according to Russian data is said to give higher values for its mechanical strength and permanent elongation at the breaking point.

POSSIBLE PRODUCTION PROGRAM

With the experience of the past year as a basis what are the possibilities of a substantial kok-saghyz program? Lack of seed is the chief "bottle neck" to any immediate large-scale production. With the seed on hand it would be possible to build up the acreage of kok-saghyz to 9,000 acres by the fall of 1943, to 70,000 acres in 1944, and 800,000 acres in 1945. As much as 2,000,000 could be planted in 1946.

Only an insignificant quantity of rubber would be possible from the 1943 crop, not a great deal (1400 tons) from the 1944 crop, but it should be possible to produce 16,000 tons from the 1945 crop, and up to 40,000 tons of rubber from the 1946 crop. However, in order that such a program could be carried out in the event it is decided desirable to do so, it will be necessary to sow and plant in 1943 the maximum area possible with the seed on hand and the vegetative propagating stock available.

The experimental test plantings of 1942 will yield enough roots so that 530 acres can be propagated vegetatively in the spring of 1943. With the 8,750 pounds of seed on hand, and 1,800 pounds now en route from Russia, and sowing at the rate of two pounds per acre, approximately 5,300 acres can be seeded. Enough seed can be collected early in July from the spring plantings to permit early-summer sowing of an additional 3,200 acres. Thus at the end of the 1943 growing season there would be over 9,000 acres of kok-saghyz roots and 124,000 pounds of seed. At least 700 acres of roots would be needed in 1943 for pilot-plant tests of rubber extraction methods, leaving 8,300 acres for further seed production in the following year.

If an early effort were made through diplomatic channels for the collection of 50 tons of seed in Russia in the summer of 1943, for sowing in the spring of 1944, it is calculated that the seed yield that fall would be 1,000,000 pounds, and the rubber yield 1,000 tons. This could mean an additional 10,000 tons of rubber in 1945. There is a possibility, too, that if the growing of seed in the South during the winter proves feasible, a more rapid expansion could be accomplished. There is some promise in this method since test plantings made during the past fall in the Everglades are now beginning to bear seed.

Details of the production plan are tabulated on the following pages.

KOK-SAGHYZ PRODUCTION PLAN
for a program to continue through 1945

POSSIBLE PRODUCTION - 1943

			Seed Collection				On Hand at End of Season			
			Early Summer		Late Summer		Full Yr.	Short Yr.		Green
		Field	Rate	Total	Rate	Total	Roots	Roots	Seed	Roots
		Acres	lbs.	lbs.	lbs.	lbs.	Acres	Acres	lbs.	Tons
Acres Roots (North Plantings)	(Lift, segre-	375	3	1,125	30	11,250	375	-	11,250	-
Acres Roots (Sample Plots)	(gate trans- (plants and	15	3	45	50	750	15	-	750	-
Acres Roots (South Plantings)	(cuttings and (replant.	140	-	-	25	3,500	140	-	3,500	-
8,750 lbs. seed (on hand)	Sow early;	4,375	1	4,375	20	87,500	3,675	-	87,500	1,400
1,800 lbs. "(enroute fr.Russia	(dig 700 (acres for	900	1	900	20	18,000	900	-	18,000	-
6,445 lbs. "(summer collection	(Pilot Mill Sow immed'ly	3,222	-	-	1	3,222	-	3,222	3,222	-
						Total	5,105	3,222	124,222	1,400
	POSSIBLE PRODUCTION - 1944									
530 acres cutting stock	Hold for seed	530	50	26,500	-	-	-	-	26,500	1,060
7,797 acres roots(seedlings)	then harvest	7,797	50	389,850	-	-	-	-	389,850	15,594
124,222 lbs. seed ('43 collection)	Sow in spring collect seed, harvest roots in fall	62,111	-	-	20	1,242,220	-	-	1,242,220	124,222
						Total	-	-	1,658,570	140,876
100,000 lbs. seed if obtained from Russia by April 1	Sow in spring, collect seed, harvest roots in fall	50,000	-	-	20	1,000,000	-	-	1,000,000	100,000
	POSSIBLE PRODUCTION - 1945									
1,658,570 lbs.seed('44 coll'n)	Sow in spring	829,825	-	-	20	16,585,700*	-	-	16,585,700	1,658,570
1,000,000 lbs.seed(expansion of 1944 Russian seed)	collect seed harvest roots in fall	500,000	-	-	20	?	-	-	?	1,000,000

Note: In 1946 and thereafter it will be possible to produce 2,000,000 acres or more if desired.
*Propose to collect only enough seed for the 1946 program.

SIGNIFICANCE OF 1943 PLANTINGS
as a basis for the continuing of the Program

While the amount of rubber produced from the 1943 kok-saghyz crop is very small, and the expenditures required might appear to be out of all proportion to the immediate contribution of rubber to the war effort, the estimated absolute minimum requirements of natural rubber in 1944 and 1945 should determine the decision to be made with respect to the 1943 kok-saghyz program. The investment of $5,400,000 in the crop year 1943, as a single crop with no thought of a continuing program, should not be regarded as the purchase of 180 tons of rubber at a cost of $15.00 per pound (which cost for purely experimental purposes might be justified) but as an investment in experience, plant equipment, and skilled workers (seed and the operating organization) from which 1400 tons of rubber could be produced from the 1944 crop and 16,000 tons of rubber from the 1945 crop, and greater quantities in subsequent years if necessary.

Conversely, should the 1943 program be not initiated or be reduced greatly, there is no assurance that production of 16,000 tons of kok-saghyz rubber from the 1945 crop (to be extracted during the fall of 1945 and in 1946) could otherwise be attained. To rely on the possible importation of sufficient seed from Russia to expand to worthwhile rubber production in 1944 or 1945 would be risky, as the availability of great quantities of seed in Russia at that time is problematical. Furthermore, the purity of such seed, if it were obtainable, would be subject to question, and the organization here would have had no experience in large-scale production before entering into such a tremendous agricultural program with all of its attendant difficulties.

If careful consideration of the present and future military and civilian needs for natural rubber makes desirable the initiation of a kok-saghyz program as an emergency measure of rubber insurance, the use of all available seed in the spring of 1943 is necessary to realize the maximum potentialities of the program in 1944 and later.

If a decision is reached by February 1, that the program for 1943, 1944, and 1945, as outlined on the preceding pages, is not desired it would be possible to put into effect the production program outlined below. As indicated, this program would, at the end of the 1943 rowing season, supply 12,000 pounds of seed and 116 tons of rubber. For a fuller explanation of deadline data on this program, and its relationship to the expanded program, please refer to pages fourteen and fifteen.

Kok-saghyz Production Plans for 1943 Only
(No provisions for expansion in 1944 & 1945 are included)

Item	Action	Field: Acres	Seed Collection: Rate: lbs.	Seed Collection: Total: lbs.	Green Root Production: tons	Possible Rubber Production: tons
Acres of Roots (from northern States)	Lift, segregate transplants & cuttings & re-plant	375	30	11,250	750	7.5
Acres of Roots (from Sample Plots)	Lift, segregate transplants & cuttings & re-plant	15	50	750	30	.3
Acres of Roots (from southern States)	Lift, segregate transplants & cuttings & re-plant	140	-	-	280	2.8
8,750 pounds of seed (on hand)	Sow early	4,370	-	-	8,740	87.4
1,800 pounds of seed (en route from Russia)	Sow early	900	-	-	1,800	18.0
Total	-	5,800	-	12,000	11,600	116.0

MAJOR PROBLEMS CONNECTED WITH THE PROGRAM

Land Availability

To carry on the plantings under consideration for 1943 would require about 9,000 acres of suitable land - peats and mucks and mineral soil rich in organic matter. Aside from experimental plots the initial 9,000 acres would be locally concentrated as much as possible to facilitate intensive production and management. The acreage would be centered in 10 localities in six states tentatively allocated as follows: Minnesota - 3; Michigan - 3; Wisconsin - 1; Montana - 1; Oregon - 1; New York - 1. Since the average 900-acre unit will take less than two per cent of the total farm area in a restricted zone within a 5-mile radius, there should be little difficulty in renting the required acreage.

If the program is extended in the future, both the number of units and their size would necessarily increase. It is estimated that a single rubber extraction plant would handle 187,500 tons of roots annually or the production from about 90,000 acres. Planting to kok-saghyz of 5 per cent of all land within a 30-mile radius would be necessary to reach this acreage. It probably would be found necessary to plan on smaller production units and longer shipments.

In 1945, when it would be possible to expand the acreage to over 800,000 acres from American seed sources, the difficulty of arranging for the necessary land will be much more of a problem even though the growing of the crop would be, in that year, practically all contracted to farmers. To ease the competition with other essential crops it would then be desirable to spread the program over a wider territory. Data at hand indicate that in addition to the states named above, good root production may be obtained in Iowa, South Dakota, Illinois, Vermont, and perhaps in Indiana and Ohio, although seed production is not promising in some of these states.

Crop Displacement

Crops displaced in this program would be chiefly corn, small grains, potatoes, annual legumes, celery and other vegetables, and miscellaneous other crops. The amount displaced in 1943 would be so small as to be almost insignificant. In 1944, the area, although appreciable in size, would not be sufficient to affect seriously the total food production for the country; nor would the crop area displaced in any locality be large enough to be disrupting. Only in 1945, when more than 800,000 acres are contemplated for kok-saghyz production would the program cause material displacement of crops.

It is estimated that for the country as a whole, the area needed for kok-saghyz in 1945 would displace about 1/2 of 1 percent of the corn crop, about 2½ percent of the potato acreage, approximately 2/10 of 1 percent of the land in small grains, wheat, and annual legumes, and less than 1 percent of the vegetable crop acreage.

With the possible exception of potatoes, it is believed the impact on various crops would not be serious. Even in the case of potatoes, it would not be so serious as it first appears since other less essential crops would in turn give way to potatoes. There would, of course be local adjustments to work out and this would vary from place to place. For example, in the West some sugar beet acreage might be needed for kok-saghyz and in turn sugar beets might replace other irrigated crops.

Labor Requirements

Kok-saghyz crop production practices are very similar to sugar beets or truck crops. These require a maximum of labor per unit of area even though machinery is used for many of the operations. The necessity of intensive seed collection increases the labor requirements because seed production practices are more intensive than those required for root production only. Weeds in particular must be kept out to avoid collection of weed seed along with the kok-saghyz. Seed picking, if done by hand, would require four or five persons per acre for a period of about 80 days. Consequently, mechanical seed pickers which would enable one man to handle 12 acres, once over daily, for the season, are a vital necessity.

It is estimated that 50 man-days per acre distributed approximately as follows: January to March 2%; April to June 37%; July to September 55%; October to December 6%, would be required to produce the crop.

Fortunately, the peak load comes in midsummer when high school students are available. Moreover, the type of work requiring most of the labor (hoeing, weeding, and seed collection) can be done by boys and girls and by women. It is believed that students and women would make up 75 percent of the labor required and that school buses could be hired to transport them to work. Such organization of labor would serve as a pattern for other farm activities requiring similar help and would be coordinated with other needs. Some additional labor would, no doubt, be obtained from that normally used to produce crops that would be displaced.

In 1943, during the peak labor season, it is estimated that .6 man per acre would be required. If the program were continued to future years better preliminary eradication of weeds prior to sowing, better adaptation of machinery and a smaller proportion of the total area in seed production should reduce the peak-load requirement. The requirement might well drop to .4 man per acre in 1944, and to .3 man per acre in 1945.

On this basis the peak-load requirement in 1943 would be 5,400 men or an average of 540 men in each of 10 production centers. If care were taken to locate the centers in the vicinity of small cities remote from industrial centers it should not be difficult to recruit such a small number of workers. If the program were extended to 70,000 acres in 1944 a peak load of 28,000 workers would be required and 240,000 in 1945 for the cultivation of 800,000 acres.

Recruiting the necessary field supervisory force (foremen and straw-bosses) should not be a serious problem in 1943. Some of the manpower necessary for supervision as well as common labor required would necessarily be in competition with essential industry including agriculture.

Machinery, Equipment, and Other Critical Materials Needed

Because of the intensive practices required for seed production, enough equipment must be under full government control so that operations can proceed on time and not be forced to await the convenience of the farmer. The machinery required for crop production, as given in the tabulation on the following page, is for the most part regular farm equipment or such equipment adapted to kok-saghyz culture.

Much of the equipment would be available on the farms and it is proposed to obtain the maximum amount by purchase of secondhand idle equipment or by rental. However, specialized equipment, such as four-row seed drills, four-row mechanical seed pickers, and the root lifters, are not available on farms and must be fabricated. Parts of standard machines already being manufactured will be used to the fullest extent possible in their design.

Procurement of sufficient trucks may be the most difficult equipment problem to meet if the program goes forward on a large scale, although in 1943 construction of mechanical seed pickers is the most critical.

Spraying or dusting equipment, as well as the necessary chemicals, must be made available for any insect or disease control measures that may be required.

A tabulation showing the estimated requirements in terms of critical materials for the crop production and extraction phases of the operation is shown below. A pilot plant should be built in the summer of 1943, one extraction plant should be ready for use in the summer of 1944, and 7 or 8 additional plants would be required by the fall of 1945.

EQUIPMENT REQUIREMENTS BY CROP YEARS
for a program to continue through 1945

ITEM	Number Pieces Needed under Government Control		
	1943	Additional 1944	Additional 1945
Farm Equipment			
Tractors, wheel type	80	800	-
Plows	80	800	-
Discs	80	800	-
Harrows	80	800	-
Cultipackers	80	800	-
Drills	100	1,000	4,200
Fertilizer Spreaders	25	250	750
Cultivators	80	800	-
Seed Pickers	700	5,100	-
Machines, topping	10	900	9,750
Diggers, root	15	700	7,300
Automotive Equipment			
Trucks, 1½ ton	400	800	1,200
Trucks, pickup	600	-	1,200
Cars, passenger	220	200	400

CRITICAL MATERIALS REQUIRED
for a program to continue through 1945

ITEM	Crop Year 1943			Crop Year 1944			Crop Year 1945		
	Iron & Steel	Brass & Copper	Rubber	Iron & Steel	Brass & Copper	Rubber	Iron & Steel	Brass & Copper	Rubber
	tons	tons	tons	tons	tons	tons	tons	tons	tons
Farm Equipment 1/	175	1.6	.4	2,073	14.2	3.3	7,659	19.5	4.9
Automotive Equipment 1/	1,215	8.5	16.2	1,350	7.0	18.0	3,000	19.6	40.0
Extraction Plants 2/	153	8.0	-	306	16.0	-	2,842	168.0	112.0

1/ Based on assumption that 25 percent of the regular farm equipment and 50 percent of the automotive equipment would be new, the balance to be obtained secondhand.

2/ Based on construction of a pilot plant in 1943 estimated to require 1/3 of the materials of one full sized plant. This would be enlarged to a full sized plant in 1944. Seven additional plants would be built in 1945.

EQUIPMENT REQUIREMENTS

for 1943 crop only, with no provision for additional equipment needs in 1943 for the 1944 and 1945 crops.

ITEM	Number of pieces needed under Government Control
Farm Equipment	
Tractors - wheel type	50
Plows	50
Discs	50
Harrows	50
Cultipackers	50
Drills	100
Fertilizer Spreaders	25
Cultivators	50
Seed Pickers	35*
Topping Machines	60
Root Diggers	115
Automotive Equipment	
Trucks - 1½ ton	100
Trucks - pickup 1/2 ton	50
Cars - passenger	20

*To collect only seed enough to replace that sowed in 1943.

CRITICAL MATERIALS REQUIRED

for 1943 crop only, with no provision for purchases to be made in 1943 for the requirements 1944 and 1945 Crop Year.

ITEM	Crop Year 1943		
	Iron & Steel	Brass & Copper	Rubber
	tons	tons	tons
Farm Equipment	68	.25	0.1
Automotive Equipment 1/	210	1.	2.7
Pilot Extraction Mill (requires 1/3 of materials of full sized plant)	153	8.0	-

1/ Based on assumption that 25 percent of regular farm equipment and 50 percent of the automotive equipment would be new, the balance to be obtained secondhand.

Technical Problems

The kok-saghyz program is based on a very limited American experience, supplemented by published Russian results, some of which are inconclusive. Consequently, there are many technical problems that need further study, These are concerned with crop production, equipment, root storage, rubber extraction methods and tests of rubber quality.

Crop Production Phases

1. Determination of winter losses, especially of fall-sown plants, should be made in the spring of 1943. The possibility of reducing such losses by mulching should also be explored.

2. Simplification of seed treatment is needed since the Russian method of vernalization is cumbersome.

3. Expert advice on soils is needed to avoid costly mistakes and the technique of kok-saghyz field culture including sowing, spacing, fertilizing, cultivating, weed control, and irrigation needs working out and improvement in connection with field operations.

4. Improving rubber content by roguing and plant selection has good potentialities. The seed received from Russia appears to be a "wild" collection. The opportunities for improvement by weeding out low rubber-yielding "strains" would seem to be great. This will call for careful definition and identification of the various types.

5. Investigations of insects and disease should be currently prosecuted and control methods worked out.

6. Determination of yields of seed, of roots, and of rubber for different localities and soils should be continued in order to give direction to the planting efforts.

Design of Production Equipment

1. The mechanical seed picker now under construction is vitally needed as hand-picking of seed requires too much labor.

2. No suitable digger or lifter is available. One must be designed either as a modification of the sugar beet digger or a potato digger.

3. Topping equipment is also needed to get away from an excessive use of hand labor.

Extraction and Storage Methods

1. The effect of sunlight on rubber content of roots should be determined. If the effect is not too serious, sun-drying of roots and tops might save more expensive ways of handling and storage.

2. Storage of roots in root cellars and dry storage need most careful study. A method of drying at the factory (or in the field) needs to be worked out. Effect of freezing is an important part of this study.

3. Extraction methods need to be perfected. A pilot plant should be built in 1943 in order to iron out the "bugs" before any full-sized factories are constructed. Tests of rubber quality should go hand-in-hand with extraction experiments.

HOW THE PROGRAM WOULD BE ACCOMPLISHED

Organization

An organizational set-up similar to that for guayule would be necessary to carry out a continuing program of kok-saghyz production. A director and key staff would be selected as soon as funds are allocated. A headquarters should be established somewhere near the center of operations, for example, at St. Paul, Minnesota. Unit headquarters near the field plantings would then be chosen and unit supervisors and staff assigned. Research and technical guidance would be provided by the Bureau of Plant Industry, the Bureau of Agricultural Chemistry and Engineering, and the Bureau of Entomology and Plant Quarantine like that in the guayule program.

Securing the Land

Since the initial program in 1943 would be one of seed production under full government control, land would be leased outright from farmers. This would be the first field job to undertake. Soil scientists and lease men working together would make the examination during the winter and arrange for the lease. Leases should be limited to land that had been plowed the previous fall.

Crop Production Operations

The growing of kok-saghyz calls for intensive truck-crop practices on a large field-crop scale. Preparation of land including discing, harrowing, and floating should be contracted to farmers insofar as possible. Seeding, however, including seed vernalization would have to be carried out in 1943 as a government operation in view of the special care this requires. Cultivating may be contracted, but hoeing, weeding, roguing, and seed collection would be government operations, in view of the intensity of the seed production program. Likewise, digging would be a government operation the first year.

If the program is carried forward to future years, it is expected that a larger part of it would be contracted each year directly with farmers, although some assistance by the government in making available special machinery, labor, and probably loans might be necessary. In 1944, a certain amount of government control would be necessary because the emphasis would still be on seed production, but it would be highly desirable that year to contract as large an acreage as possible. Thus experience would be gained that would be extremely helpful the following year when it is hoped the entire crop could be contracted to farmers except for a relatively small proportion to be retained under government control for seed production.

Deadline Dates for 1943 Operations of the Program To Continue through 1945

The Lake States and northern prairie states, where the greater part of the program would be carried out, are noted for their short spring season. From the middle of April, to the middle of May, there is an abrupt change from winter to an active growing season. The time for getting the crop into the ground is, therefore, exceedingly short. If the crop is to be planted on time, everything must be especially well organized. The land must be examined and leased while there is still snow on the ground. A very carefully prepared seedbed must be made ready immediately the soil is dry enough to work, and the sowing must be done with precision as to depth on a time-table schedule, otherwise valuable growing time is lost and the anticipated seed yields will not be attained. Such a program is entirely feasible, but there can be no slips in organization of the work if it is to succeed.

In view of the fact that it is already somewhat late to undertake a program in 1943, administrative action on various operations must not be delayed a day longer than necessary. The following deadlines are therefore set up as a guide:

1943 DEADLINE DATA

1. Because of the extremely short spring season in the region where kok-saghyz should be planted, if any program is to be authorized, decision must be reached by — February 1

2. Inasmuch as some modification of standard seed sowing equipment is necessary, these machines must be ordered by — February 3

3. Orders for specially built seed-picking equipment must be placed by — February 20

   (a) Seed begins to ripen about June 20
   (b) To collect only enough seed to replace that sowed would require 35 picking machines. This would make expansion in 1944 impossible.
   (c) To collect seed sufficient to expand to the proposed 70,000 acres in 1944 would require 665 additional machines, costing about $200,000.

4.	To secure the necessary critical materials for the erection of the pilot extraction plant will require that the first purchases be made by	March 15
5.	Seed sowing equipment must be delivered by	April 15
6.	Seed picking machines for the one year only, or the continuing program, must be delivered by For the continuing program, about $300,000 in seed picking labor, in addition to the cost of the machines ($200,000) will be required.	June 15
7.	Action to lease and contract land preparation for 70,000 acres of 1944 crop must begin by	August 1
8.	If decision is made on August 1 that no program should be carried into 1944, the growing crop could still be carried to harvest and rubber extraction. Results: 12,000 pounds of seed, 116 tons of rubber, and one season of growing and organization experience.	
9.	However, if on August 1, it was decided that there existed no need for this natural rubber, all seed collection, and cultivation could be stopped, the crop plowed under, contracts with farmers cancelled, and the organization disbanded. Such action would result in the saving of about $400,000 of the $1,950,000 allocation for the single year program	August 1
10.	Equipment, adapted from standard farm machinery, for the digging of the roots, must be delivered by	September 15
11.	Completion of the pilot extraction plant	October 1

FINANCIAL REQUIREMENTS
for a program to continue through 1945

In order to organize the work and be able to utilize the seed and root propagating stock on hand to the fullest extent possible, it is estimated that $2,000,000 would be required for the balance of F.Y. 1943. An additional $3,400,000 would be required to care for the crop and collect the seed during the remainder of the first growing season, i.e., in the first half of F.Y. 1944. This includes the building up of an operating organization for future expansion and the purchase of considerable equipment, as well as the rental and preparation of 1/3 of the proposed 1944 acreage.

For the growing season of 1944, approximately $24,200,000 (including 1/3 of the cost of land rental and all of the plowing for the 800,000 acres that would be planted the following year) would be required, of which $7,100,000 would be needed in the last half of F.Y. 1944. (See table in the following pages for details of 1943 and 1944 F.Y. costs.)

Costs for the complete 1945 growing season have not been estimated in detail, but for 800,000 acres, at an average cost per acre of $150.00, it would approximate $120,000,000. The actual outlay in that year, however, would be higher by at least $8,000,000 to cover cost of constructing at least eight extraction plants at an estimated cost of $1,000,000 each. Since each plant would process the roots from approximately 90,000 acres, it would require some eight or nine plants for a program of 800,000 acres.

Estimates of unit costs per acre of crop production, based on a program to continue through 1945, are shown below:

Item	Cost per Acre		Remarks
Land Rental	$15.00		Estimate $20. first year; $15. thereafter.
Land Preparation	5.80		Very fine seedbed required.
Seed	4.50		Seed at $1.75 lb., plus vernalization
Growing the Crop	61.40		Includes $36.00 for hoeing and weeding
Harvesting	29.00		Includes topping, digging, hauling
		$115.70	
Extraction (Credit)		3.88	Credit of 9.7¢ per lb. rubber from sale of inulin
Total Field Costs		$111.82	
Operation, Automotive Equip.	$ 3.15		
Misc. Operation Costs	1.95		Includes rent, travel, communication, etc., for 10 units
Equipment Purchase	9.90		Amortized in 5 yrs. and spread over 1944 acreage
		$ 15.00	
Organization	$20.00		Includes foremen and strawbosses
Research & Tech. Guidance	3.80		
		$ 23.80	
Grand Total		$150.62	

In considering unit costs, attention should be called to the fact that extraction costs as estimated by the Bureau of Agricultural Chemistry and Engineering are 13¢ per pound, including fixed charges. However, the value of the by-product, inulin (from which alcohol would be made) is such that there would be a credit of 9.7¢ per pound, which could be applied against the cost of producing the roots.

On the basis of the estimated unit costs, where equipment purchases and other costs are charged off over a period of years, rubber would cost $3.62 per pound. Should the yield of roots per acre and rubber content turn out to be higher than the rather conservative amounts estimated, the cost of rubber would be proportionately reduced. On the other hand, if the project were considered strictly as an emergency venture and all expenditures for research, development, organization, equipment, extraction plants, etc., were written off without residual value after processing the 1945 crop, the rubber cost would compute to be $4.37 per pound.

SUMMARY OF ESTIMATED COSTS
Fiscal Years 1943 and 1944
for a program to continue through 1945

ITEM	To 6/30/43	7/1/43 to 12/31/43	1/1/44 to 6/30/44
Land Rental	$ 90,000	$ 395,000	$ 372,500
Farm & Operating Costs	254,920	708,120	2,567,560
Equipment Purchase	840,015	1,137,500	2,447,550
Production Organization			
Main Office	41,718	66,580	78,280
Unit Offices (including foremen)	263,740	538,000	653,500
Research & Technical Guidance			
Processing Investigations	41,500	50,000	50,000
Crop production machinery investigations	14,500	10,000	10,000
Soils-cultural & pathological investig'n	58,480	42,500	43,850
Insect Investigations	1,000	5,000	10,000
Processing Plants 1/	125,000	125,000	-
Other Costs 2/	269,127	322,300	866,760
Total	$2,000,000	$3,400,000	$7,100,000

1/ Plants estimated to cost $1,000,000 each or $8,000,000 - none of which would be expended until F.Y. 1945. Estimates shown are for pilot plant only.

2/ Includes supplies, travel, communications, truck operation, equipment rental, rent, light, and miscellaneous.

SUMMARY OF ESTIMATED COSTS
for 1943 crop only, with
no provision made for
expenditures to be made in
1943 for the 1944 and 1945 crops

ITEM	Period to 6/30/43	Period 7/1/43 to 12/31/43
Land Rental	$ 58,000	$ 58,000
Farm & Operating Costs	246,000	300,000
Equipment Purchases	192,000	76,000
Production Organization (including foremen)	210,000	210,000
Technical Guidance	36,000	36,000
Research	83,000	20,000
Pilot Processing Plant	125,000	125,000
Other Costs 1/	117,000	58,000
Total	$1,067,000	$ 883,000

Total for Growing Season $1,950,000

1/ Includes supplies, travel, communications, truck operations, equipment rental, rent, light, and miscellaneous.

SUMMARY

1. Kok-saghyz grows well on rich soild in the northern states from Vermont to Oregon.

2. It will produce annually two tons of roots per acre on the average, yielding forty pounds of rubber.

3. The rubber is easy to extract and is of high quality believed to be of a character suitable for the trade.

4. The returns from manufacturing alcohol as a by-product will more than offset the cost of rubber extraction operations.

5. Seed is the "bottle-neck" to rapid expansion, hence an insignificant quantity of rubber could be recovered in 1943 and not a great deal (1400 tons) in 1944. Maximum seed production under government supervision would be the major objective in 1943 and 1944.

6. With 8,750 pounds of seed on hand and 1,800 pounds en route from Russia, 9,000 acres could be planted in 1943. This would make possible an expansion to 70,000 acres in 1944. A further expansion to 800,000 acres with a production of 16,000 tons of rubber could be reached in 1945. It would be theoretically possible to plant up to 2,000,000 acres or more in 1946, from which 40,000 tons of rubber could be extracted. Again it is emphasized that the maximum seed producing acreage in 1943 is essential, if objectives like 16,000 tons of rubber from the 1945 crop are to be reached.

7. If an additional 50 tons of seed were obtained from Russia for sowing in 1944, this would mean an additional 1,000 tons of rubber that year and 10,000 tons additional in 1945.

8. Kok-saghyz culture is very similar to that of sugar beets and truck crops. These require a maximum of labor per unit of area even though machinery is used to the fullest extent possible. The necessity of undertaking intensive kok-saghyz seed collection adds to the labor requirement. Since hand picking would be too extravagant of labor, machine picking is necessary.

9. It is estimated that 5,400 laborers would be required during the peak period in 1943, or 540 in each of ten different centers. It is expected that at least three-fourths of the requirement would be met by women and high school boys and girls, since the peak load comes in midsummer. For these reasons there should be no great difficulty in obtaining sufficient help in 1943. The peak-load requirement in 1944 is estimated at 28,000, and in 1945 at 240,000.

10. It is believed that sufficient land of proper quality can be leased in 1943, and also in 1944, when production of seed would be under government supervision. In 1944 some acreage would be contracted with farmers, and in 1945 it is contemplated that root production would be entirely contracted directly with farmers and only the seed farms kept under strict government control.

11. Crops displaced would be chiefly corn, small grains, potatoes, annual legumes and vegetables. During 1943 and 1944, the areas involved would be too small to be disrupting. In 1945, the displacement would be greater, but it is not believed to be critical because the crop would be spread over a wide territory.

12. Due to the short spring season in the northern states, planting of kok-saghyz in the spring of 1943 means that there is no time to lose in getting organized. The land must be examined and leased, equipment rented and purchased, soil prepared, and the crop seeded not later than May 10.

13. It is believed that most of the farm machinery needed can be rented or purchased secondhand in 1943. Seeders, mechanical seed pickers, and lifters, however, will have to be new. Procurement of the necessary trucks may be somewhat of an obstacle.

14. Costs for a program to continue through 1945 are estimated at $2,000,000 for the balance of F.Y. 1943, and $3,400,000 for the first half of F.Y. 1944, or $5,400,000 for the growing season of 1943.

    The estimate for the last half of Fiscal Year 1944 is $7,100,000, and $24,200,000, including one-third of the land rental for the following year for the growing season of 1944. The estimates do not include the cost of planting an additional importation of Russian seed.

    No detailed estimates have been prepared for the crop year 1945, but at $150 per acre the cost would be some $120,000,000 for producing a crop on 800,000 acres, or $3.62 per pound of rubber. With favorable weather, and with higher yields than the conservative ones included in this estimate, the cost would be proportionately lower. If the entire project were liquidated after processing the 1945 crop, and no residual value allowed, the rubber would cost $4.37 per pound.

15. A recapitulation of the summary in tabular form for a program to continue through 1945 is given below:

Cal. Year	Seed available	Area to be Planted	Yield		Labor - Peak Load	Extraction Plants	Cost of Program
			Roots	Rubber			
	pounds	acres	tons	tons	No.	No.	$
1943	10,550 1/	9,000	1,400	14	5,400	1/3	5,400,000
1944	124,222	70,000	140,876	1,409	28,000	1	24,200,000
1945	1,658,570	800,000	1,658,570	16,585	240,000	7	128,000,000 2/

1/ Some vegetative propagating stock is also available.

2/ Cost of rubber in 1945 - $4.37 per pound if all research, developmental, equipment, and other costs were written off without residual value afte. processing the crop of that year. By amortizing such costs over several years, the cost per pound of ruober would compute to be $3.62. With higher yields than the conservative ones estimated, the cost would be proportionately lower.